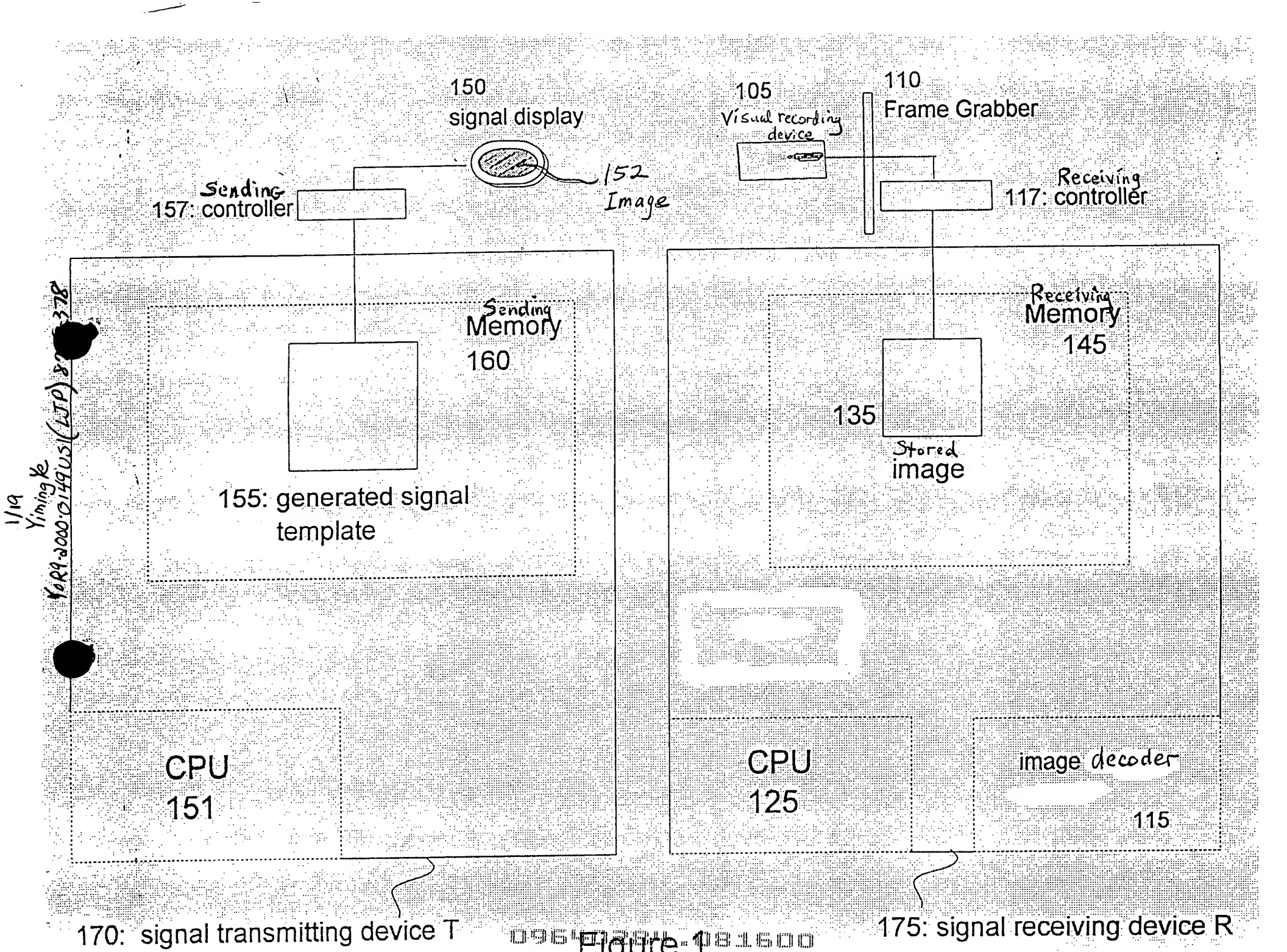
150
signal display
105
Visual recording device
110
Frame Grabber
152
Image
Sending
157: controller
Receiving
117: controller
Sending
Memory
160
Receiving
Memory
145
135
Stored
image
155: generated signal
template
CPU
151
CPU
125
image decoder
115
170: signal transmitting device T
175: signal receiving device R

Figure 1

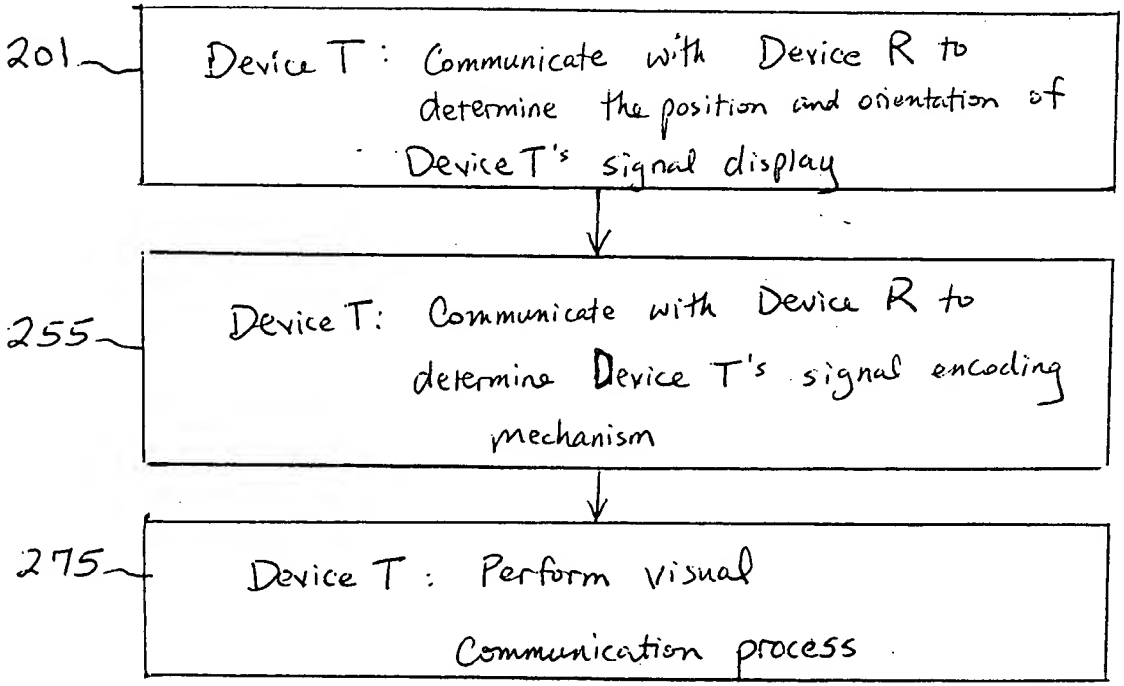
201
Device T: Communicate with Device R to determine the position and orientation of Device T's signal display
255
Device T: Communicate with Device R to determine Device T's signal encoding mechanism
275
Device T: Perform visual Communication process

FIG. 2

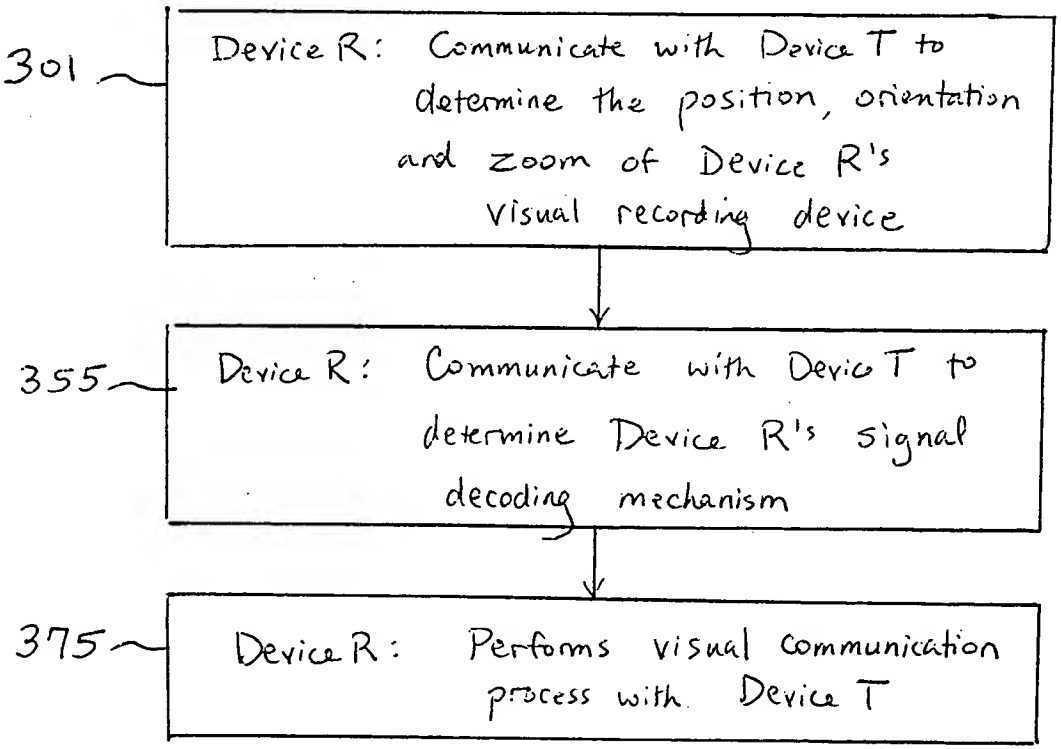
301
Device R: Communicate with Device T to determine the position, orientation and zoom of Device R's visual recording device
355
Device R: Communicate with Device T to determine Device R's signal decoding mechanism
375
Device R: Performs visual communication process with Device T

FIG. 3

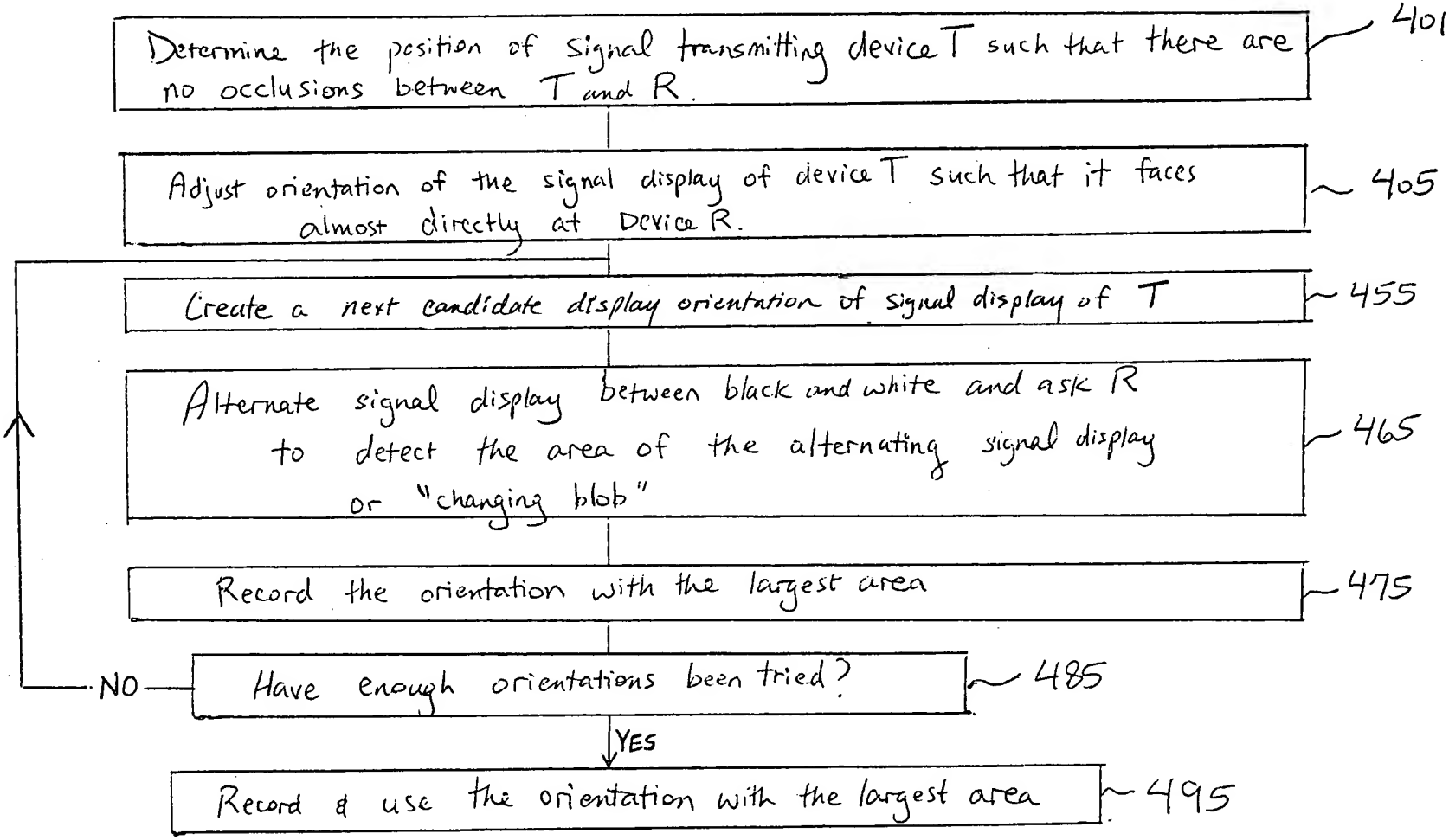

FIG. 4

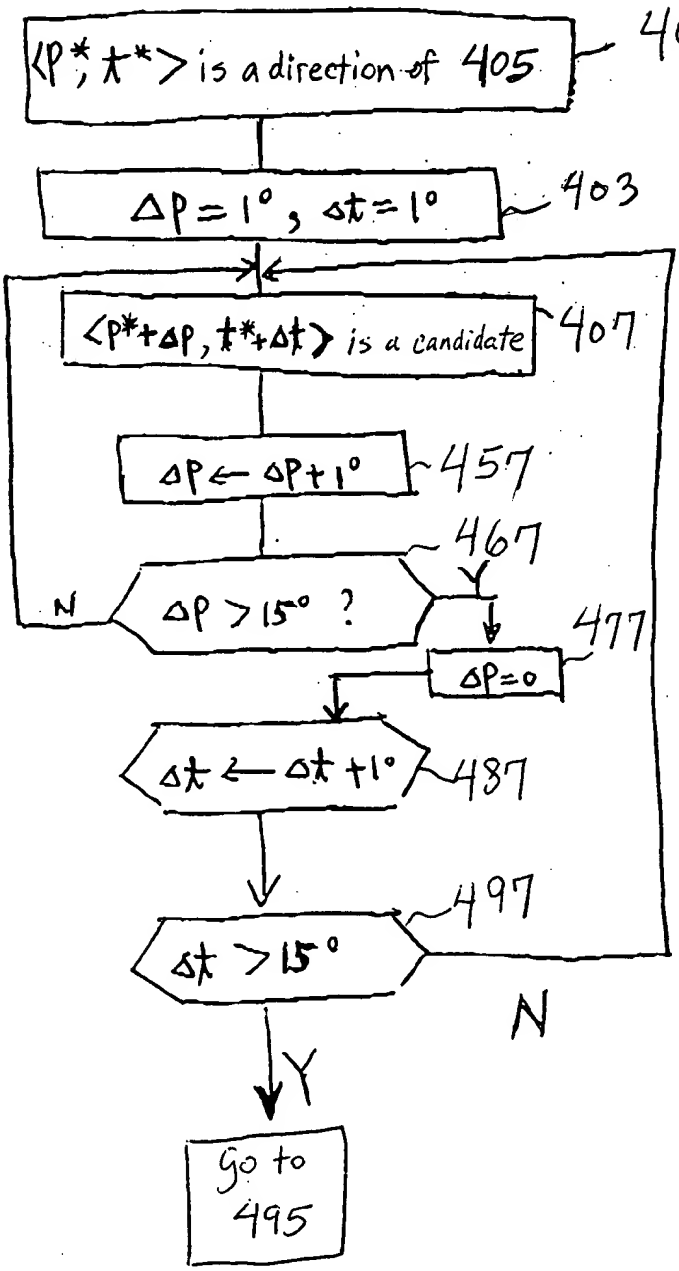
<p*; t*> is a direction of 405
402
Δp = 1°, Δt = 1°
403
<p*+Δp, t*+Δt> is a candidate
407
Δp ← Δp + 1°
457
467
N
Δp > 15° ?
Y
477
Δp = 0
Δt ← Δt + 1°
487
497
Δt > 15°
N
Y
Go to 495

FIG. 4A

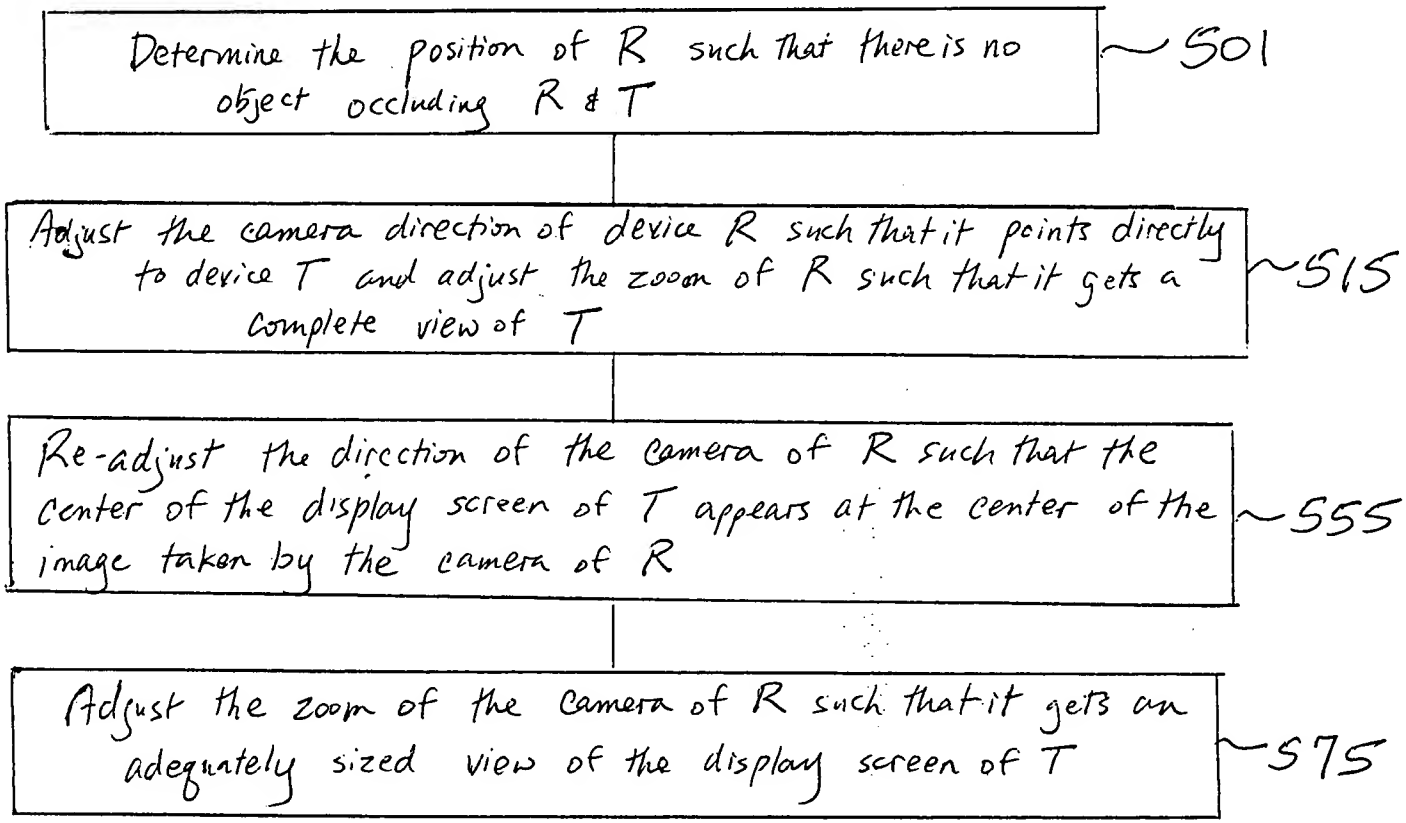
Determine the position of R such that there is no object occluding R & T
501
Adjust the camera direction of device R such that it points directly to device T and adjust the zoom of R such that it gets a complete view of T
515
Re-adjust the direction of the camera of R such that the center of the display screen of T appears at the center of the image taken by the camera of R
555
Adjust the zoom of the camera of R such that it gets an adequately sized view of the display screen of T
575

FIG. 5

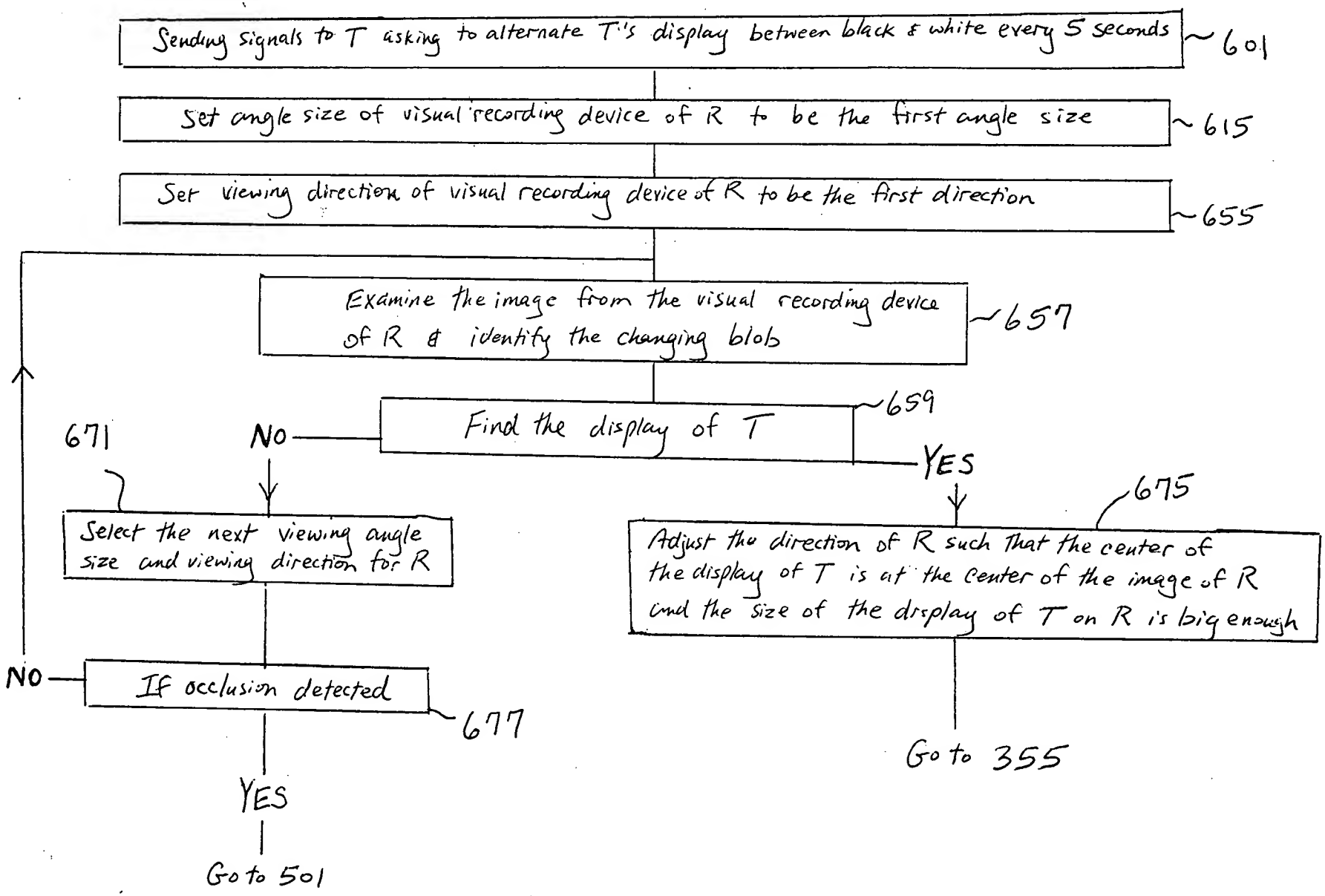
Sending signals to T asking to alternate T's display between black & white every 5 seconds
601
Set angle size of visual recording device of R to be the first angle size
615
Set viewing direction of visual recording device of R to be the first direction
655
Examine the image from the visual recording device of R & identify the changing blob
657
Find the display of T
659
NO
YES
671
Select the next viewing angle size and viewing direction for R
675
Adjust the direction of R such that the center of the display of T is at the center of the image of R and the size of the display of T on R is big enough
NO
If occlusion detected
677
YES
Go to 501
Go to 355

FIG. 6

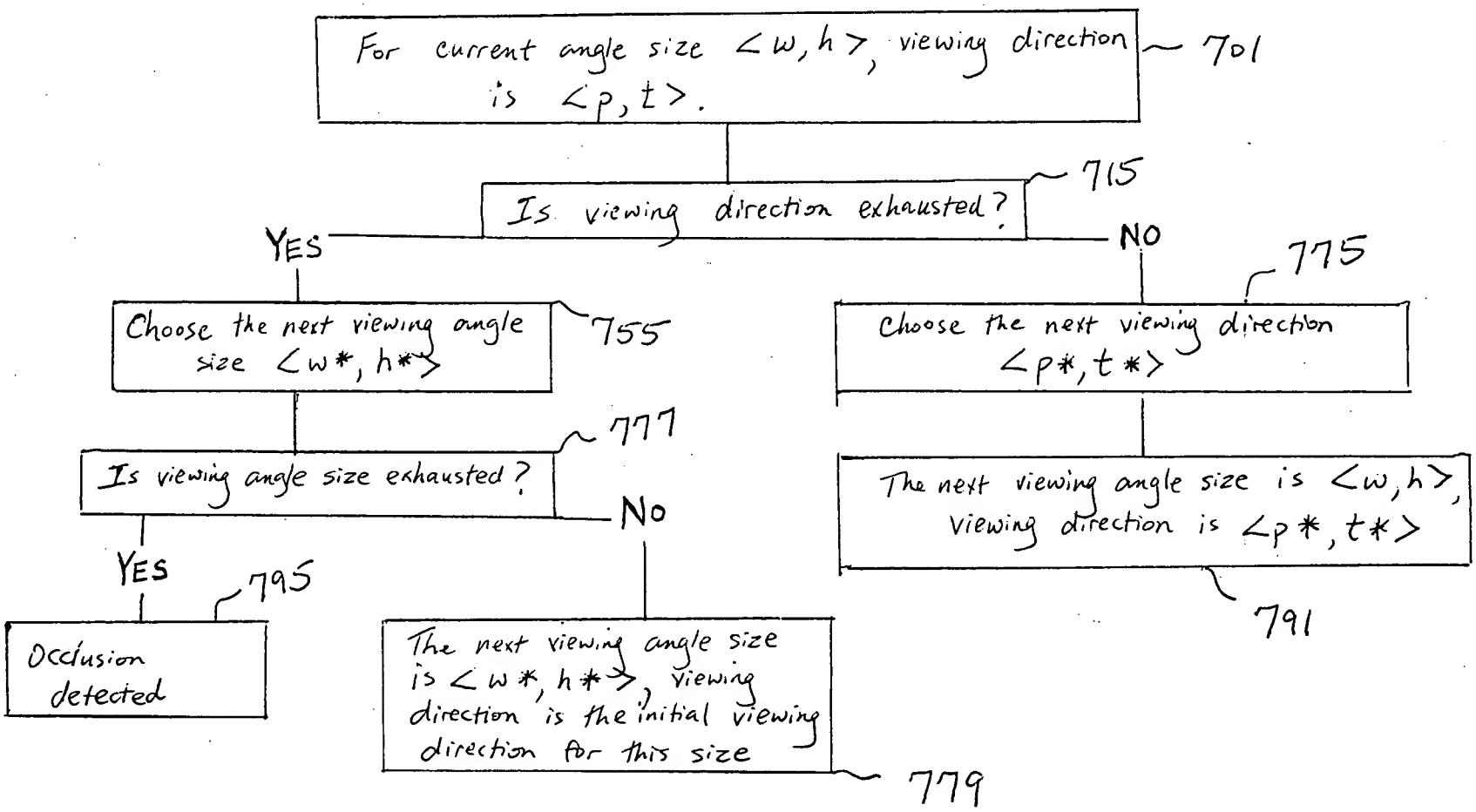
For current angle size <w, h>, viewing direction is <p, t>.
701
Is viewing direction exhausted?
715
YES
NO
Choose the next viewing angle size <w*, h*>
755
Choose the next viewing direction <p*, t*>
775
Is viewing angle size exhausted?
777
YES
NO
Occlusion detected
795
The next viewing angle size is <w*, h*>, viewing direction is the initial viewing direction for this size
779
The next viewing angle size is <w, h>, viewing direction is <p*, t*>
791

FIG. 7

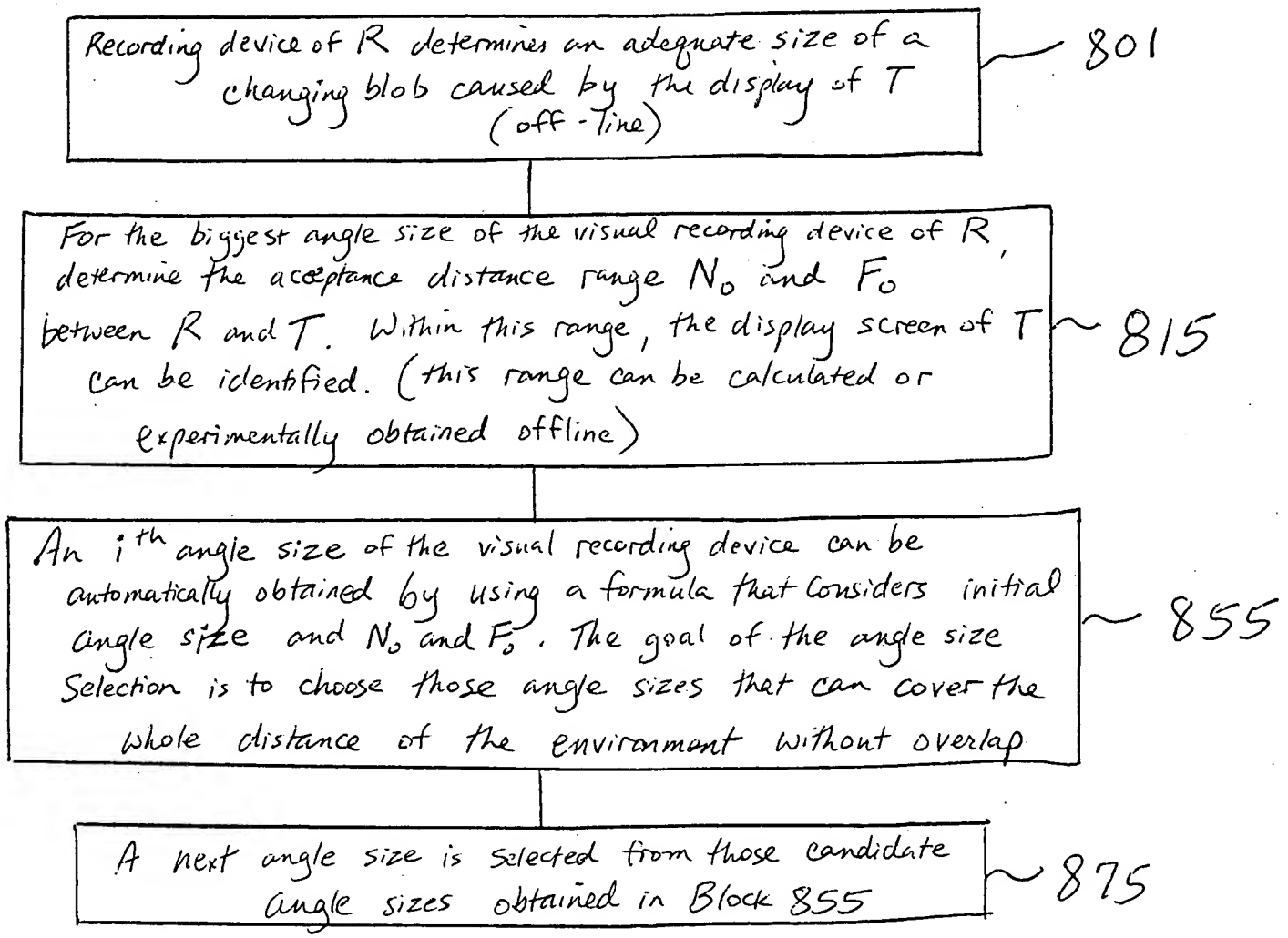
Recording device of R determines an adequate size of a changing blob caused by the display of T (off-line)
801
For the biggest angle size of the visual recording device of R, determine the acceptance distance range N_0 and F_0 between R and T. Within this range, the display screen of T can be identified. (this range can be calculated or experimentally obtained offline)
815
An i^{th} angle size of the visual recording device can be automatically obtained by using a formula that considers initial angle size and N_0 and F_0. The goal of the angle size selection is to choose those angle sizes that can cover the whole distance of the environment without overlap
855
A next angle size is selected from those candidate angle sizes obtained in Block 855
875

FIG. 8

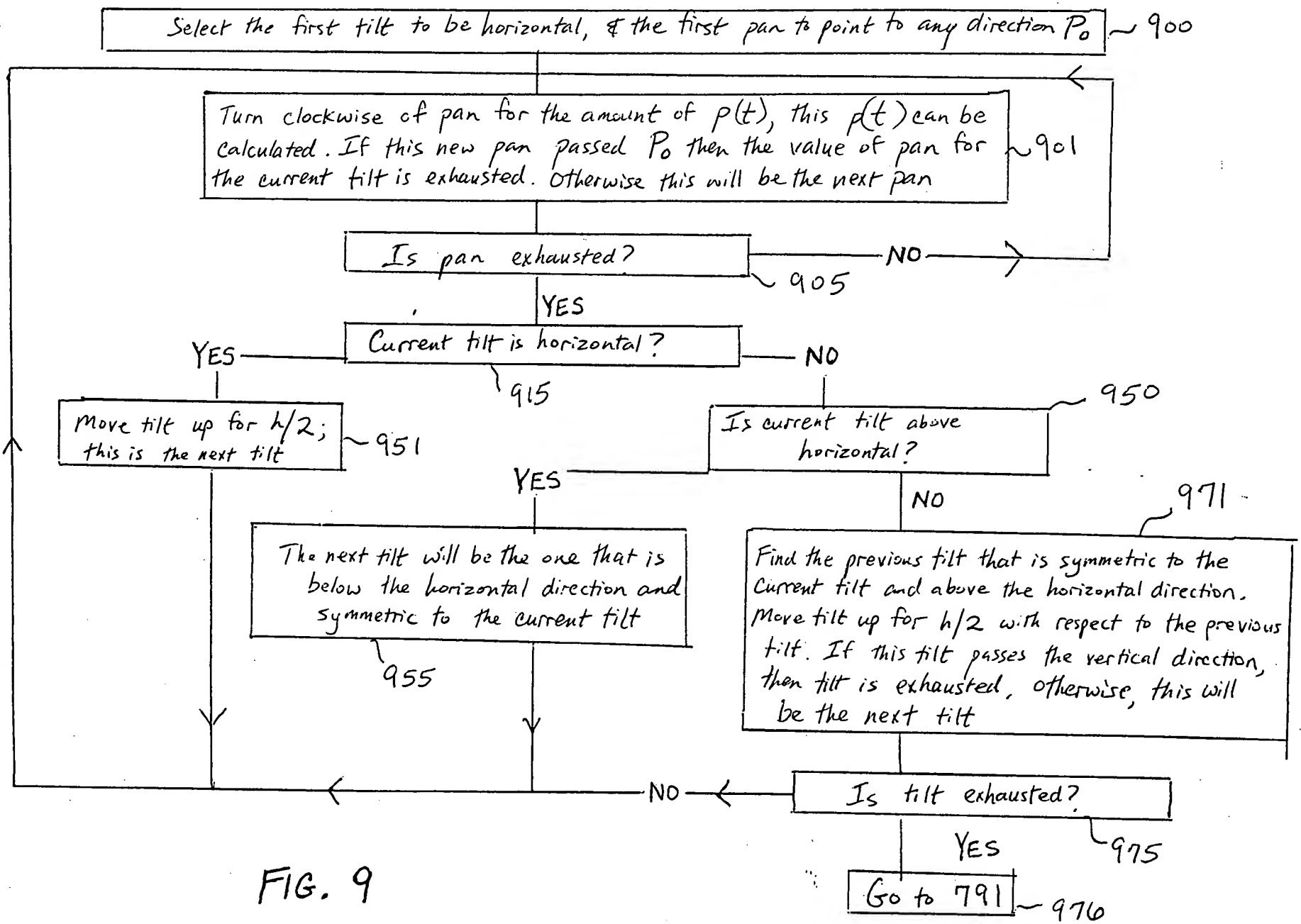
Select the first tilt to be horizontal, & the first pan to point to any direction P_0
900
Turn clockwise of pan for the amount of $p(t)$, this $p(t)$ can be calculated. If this new pan passed P_0 then the value of pan for the current tilt is exhausted. Otherwise this will be the next pan
901
Is pan exhausted?
905
NO
YES
Current tilt is horizontal?
915
YES
NO
Move tilt up for h/2; this is the next tilt
951
Is current tilt above horizontal?
950
YES
NO
The next tilt will be the one that is below the horizontal direction and symmetric to the current tilt
955
971
Find the previous tilt that is symmetric to the current tilt and above the horizontal direction. Move tilt up for h/2 with respect to the previous tilt. If this tilt passes the vertical direction, then tilt is exhausted, otherwise, this will be the next tilt
NO
Is tilt exhausted?
975
YES
Go to 791
976

FIG. 9

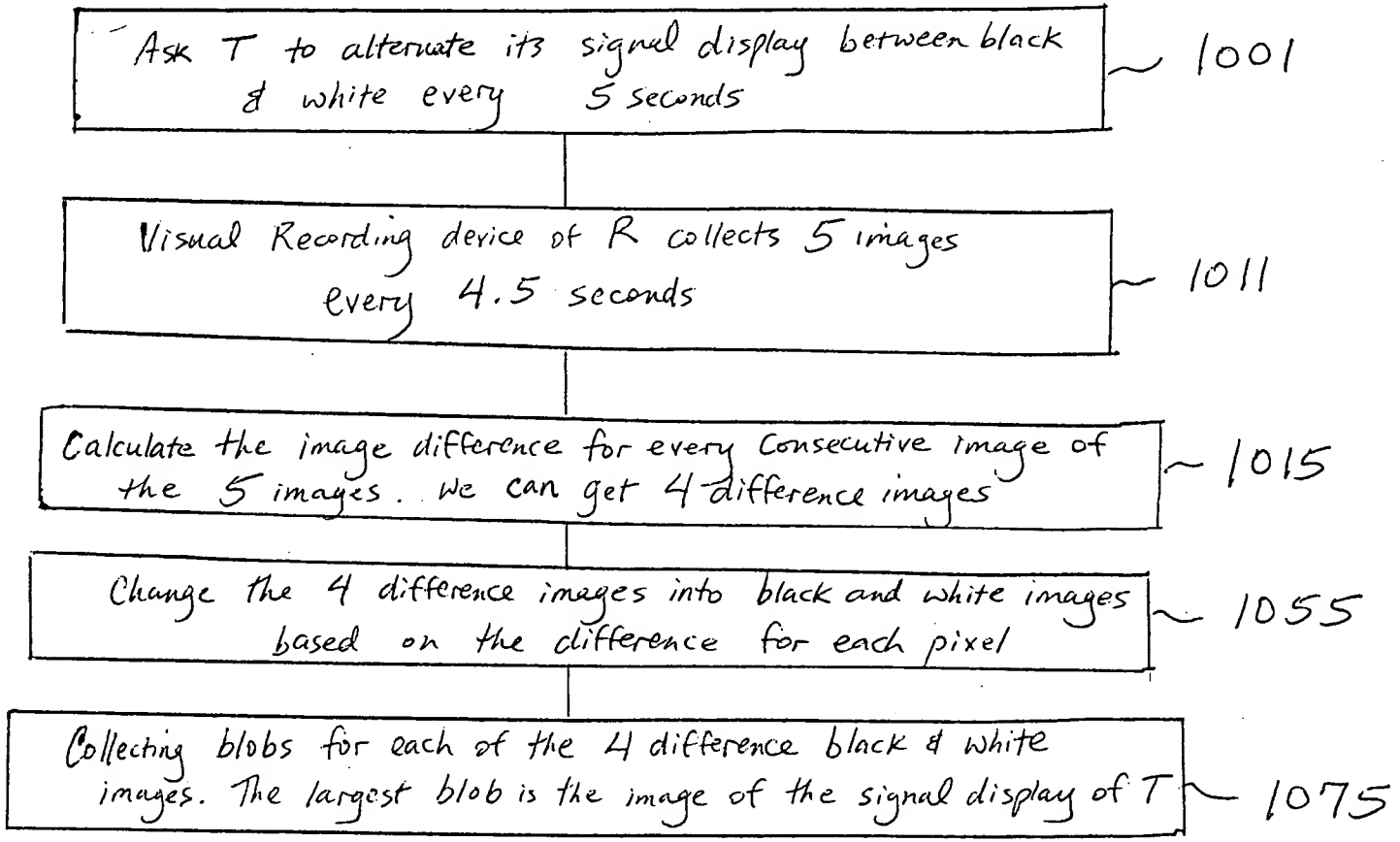

FIG. 10

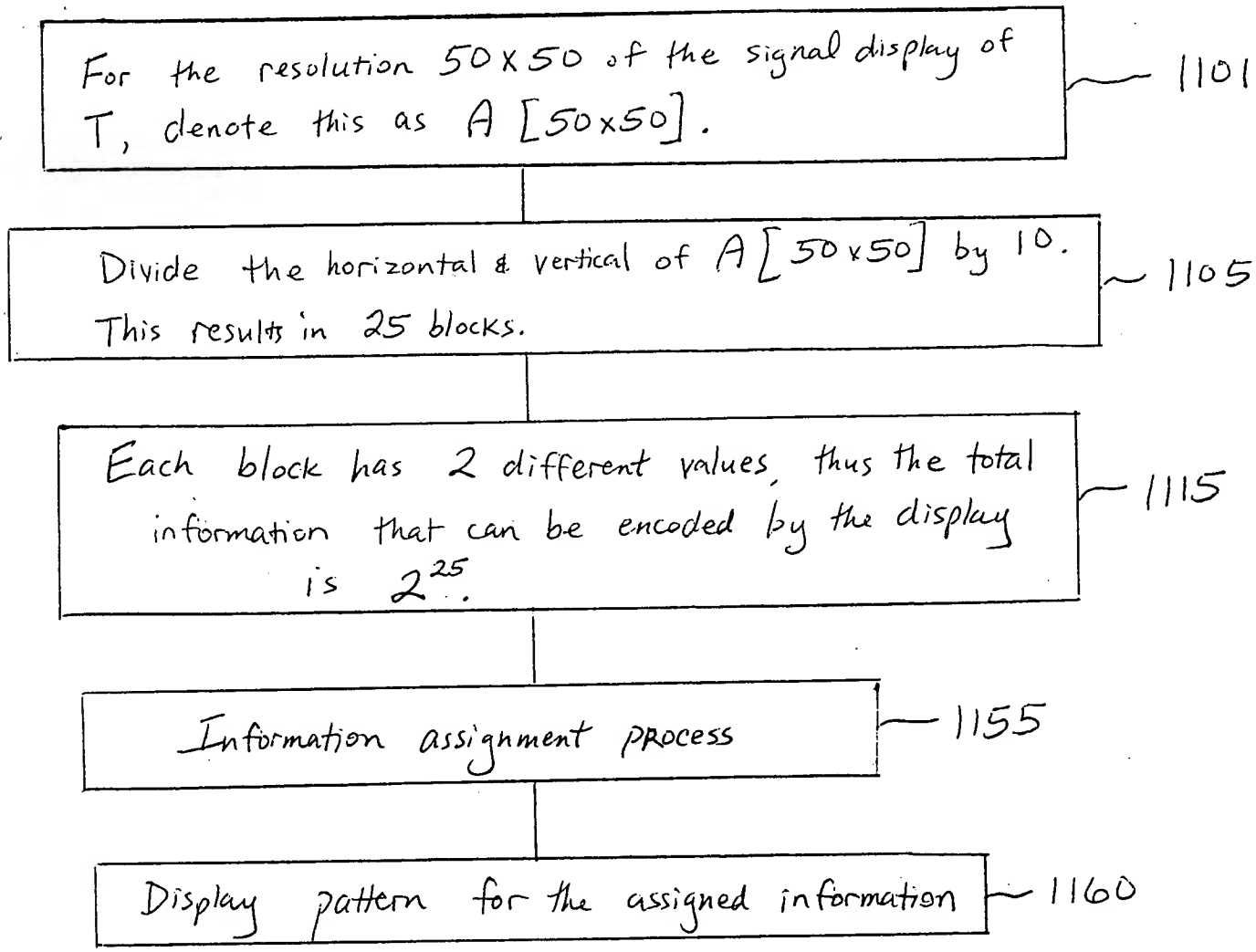

FIG. 11

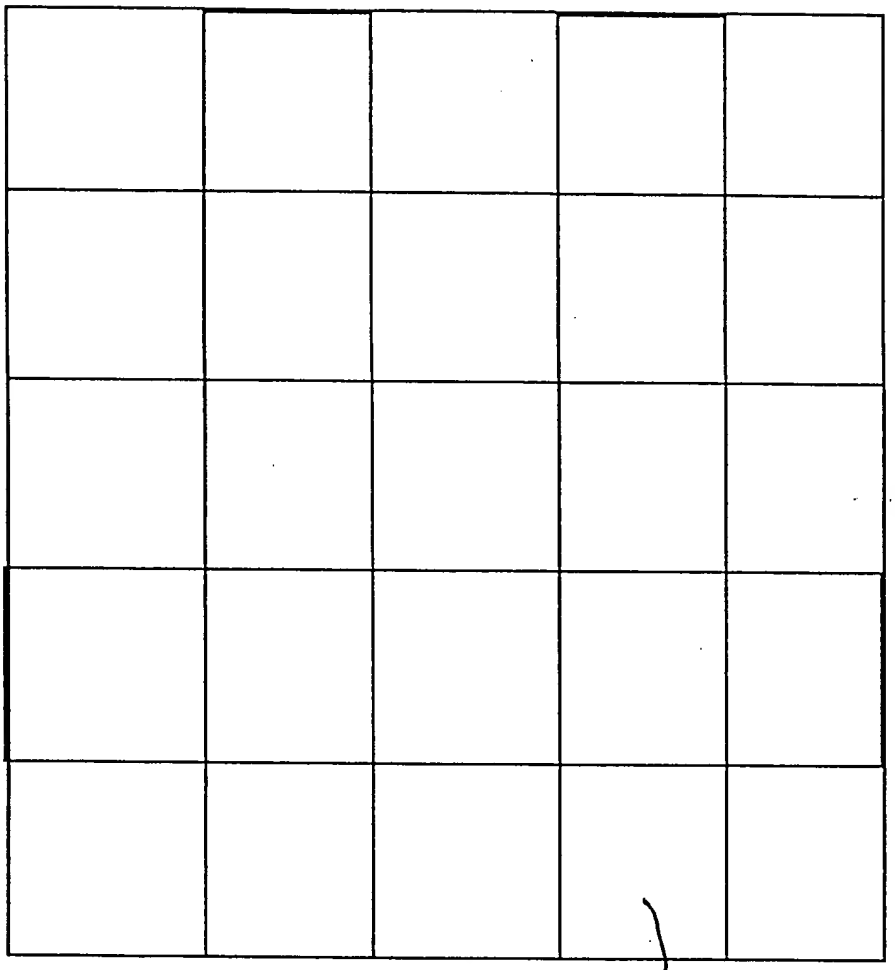

FIG. 12

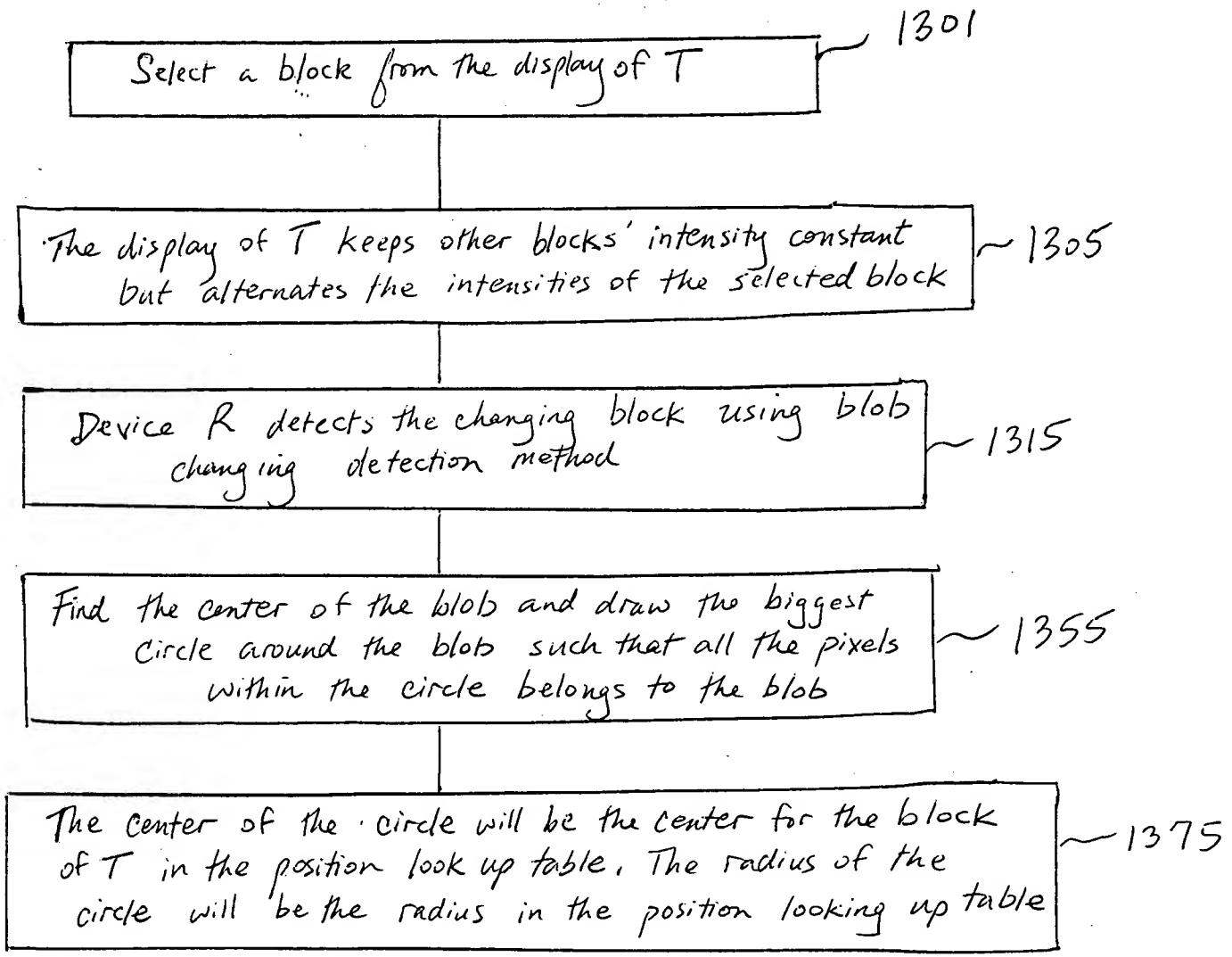
Select a block from the display of T
1301
The display of T keeps other blocks' intensity constant but alternates the intensities of the selected block
1305
Device R detects the changing block using blob changing detection method
1315
Find the center of the blob and draw the biggest circle around the blob such that all the pixels within the circle belongs to the blob
1355
The center of the circle will be the center for the block of T in the position look up table. The radius of the circle will be the radius in the position looking up table
1375

FIG. 13

YOR9-2000-0149US1([illegible]8-378)

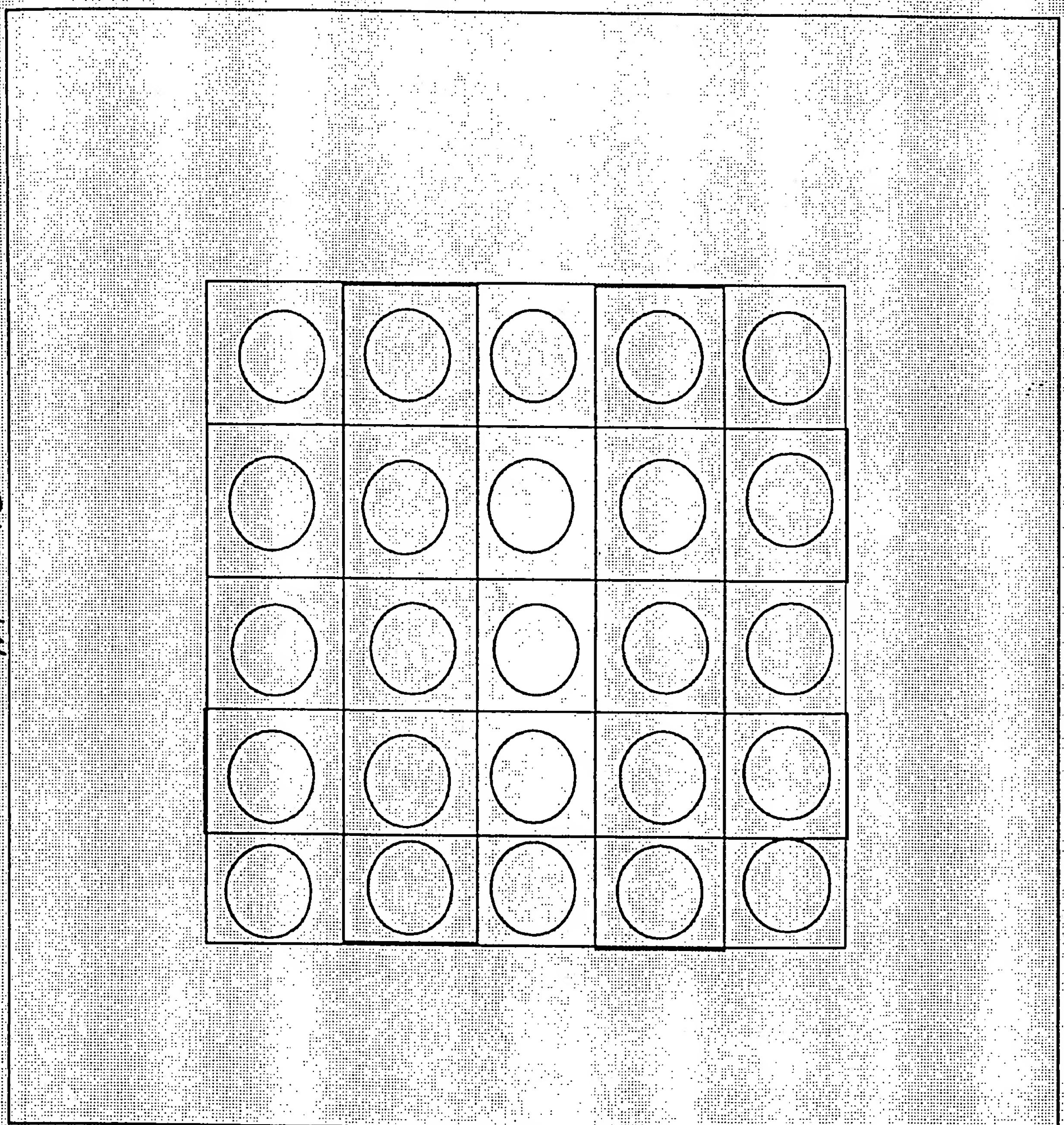

FIG. 14

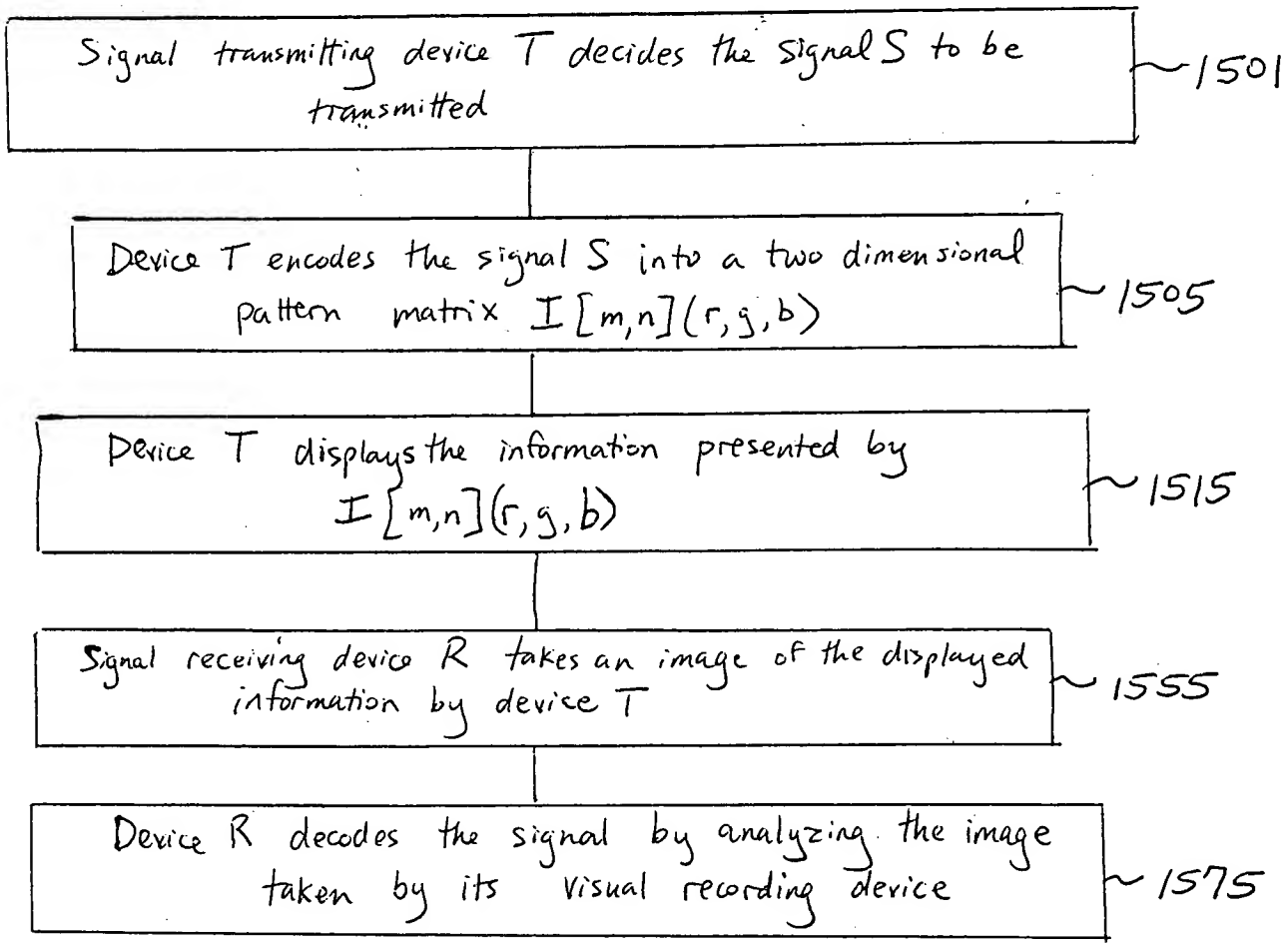

FIG. 15

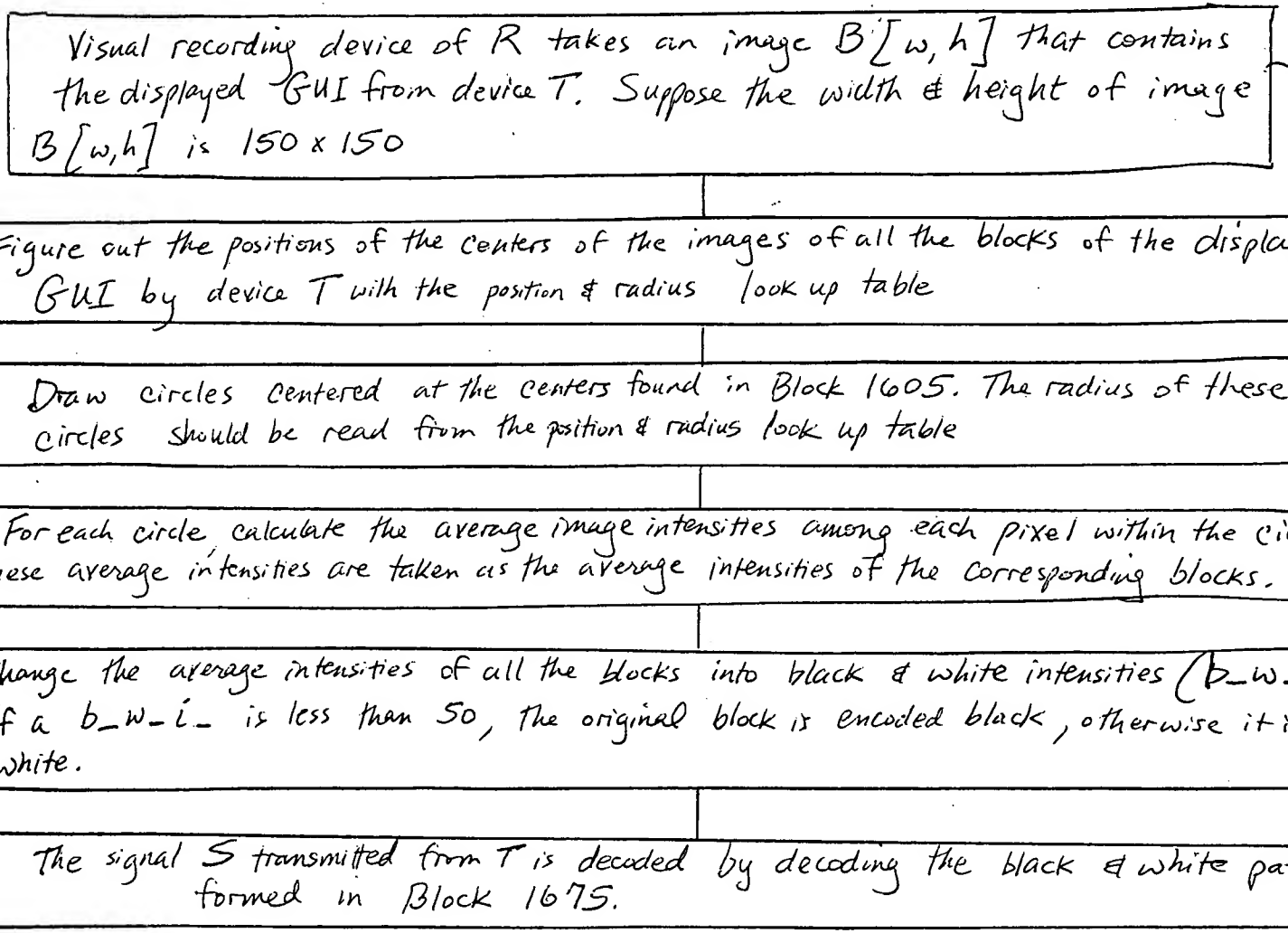
Visual recording device of R takes an image B[w,h] that contains the displayed GUI from device T. Suppose the width & height of image B[w,h] is 150 x 150
1601
Figure out the positions of the centers of the images of all the blocks of the displayed GUI by device T with the position & radius look up table
1605
Draw circles centered at the centers found in Block 1605. The radius of these circles should be read from the position & radius look up table
1615
For each circle calculate the average image intensities among each pixel within the circle. These average intensities are taken as the average intensities of the corresponding blocks.
1655
Change the average intensities of all the blocks into black & white intensities (b_w_i_)
If a b_w_i_ is less than 50, the original block is encoded black, otherwise it is encoded white.
1675
The signal S transmitted from T is decoded by decoding the black & white pattern formed in Block 1675.
1695

FIG. 16

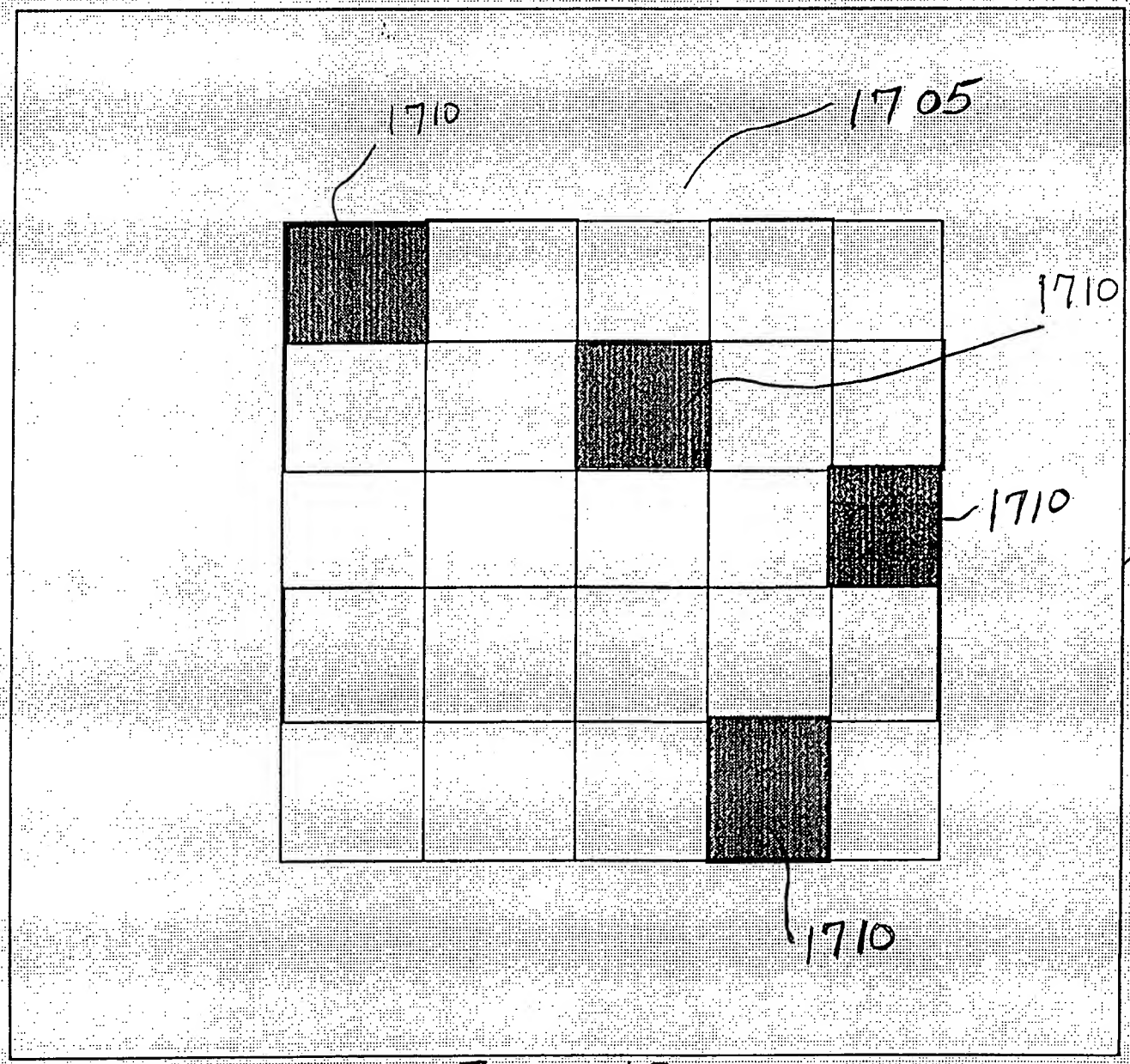

FIG. 17

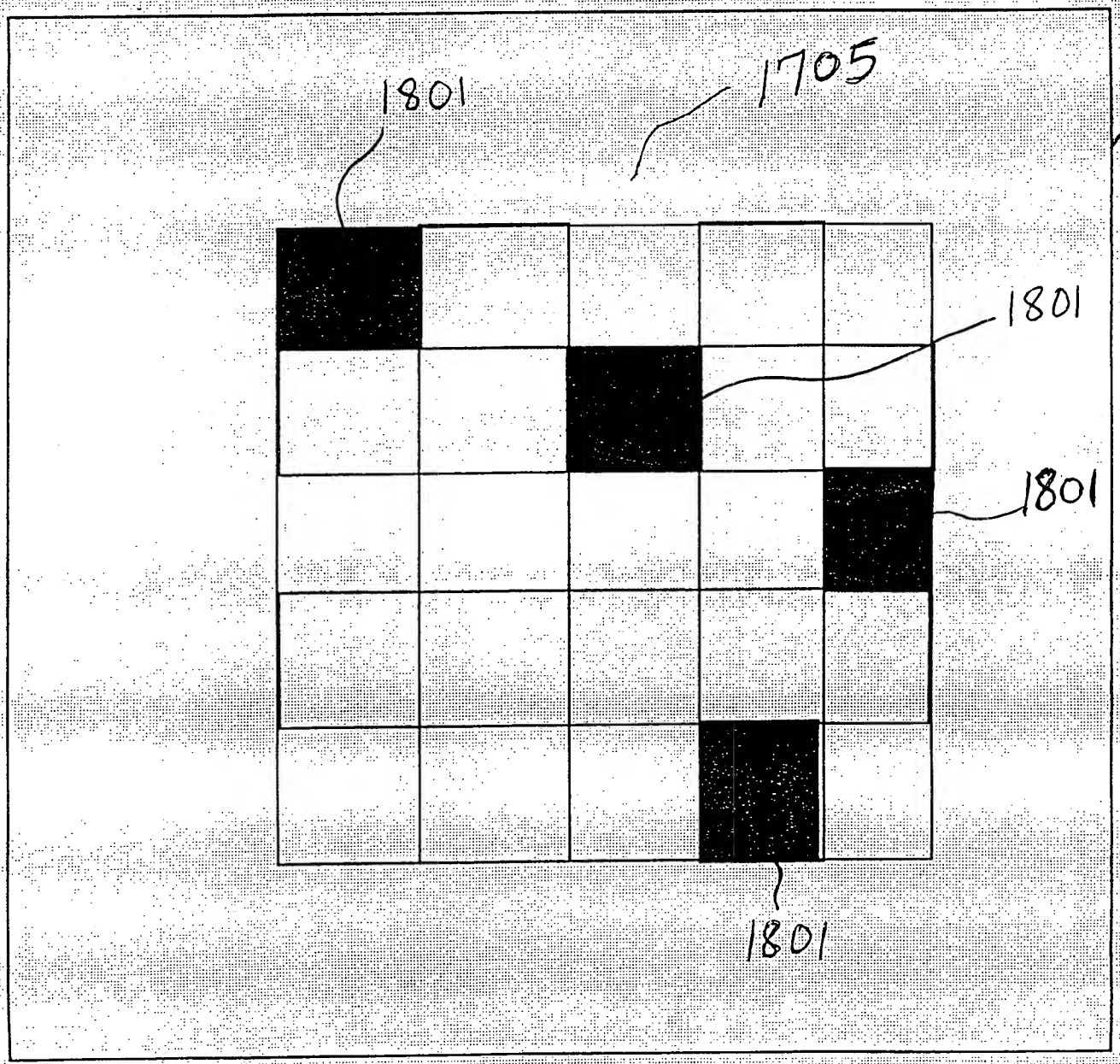

Figure 18